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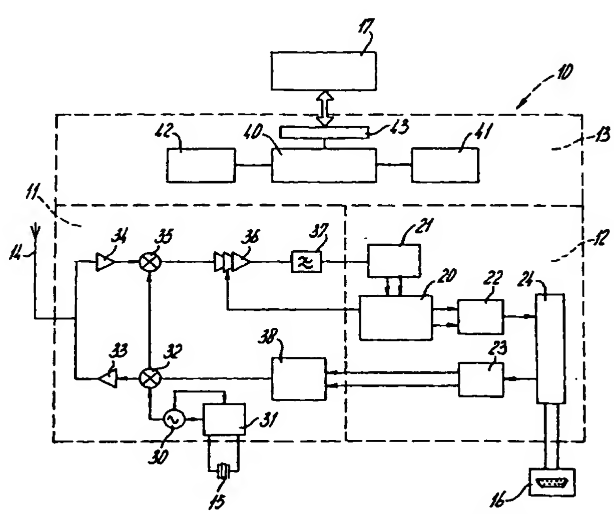
(54) Title: SINGLE CHIP SPREAD SPECTRUM RECEIVER AND TRANSMITTER FOR SHORT MESSAGES



(57) Abstract: Receiver module (10) for receiving a spread spectrum signal having a pseudo-noise code for addressing the receiver module (10), comprising a receiver processor (20) connected to main frequency signal generating means (30, 31, 15) and a spread spectrum signal input (14), the receiver processor (20) being arranged for generating an internal pseudo-noise code and synchronising the spread spectrum signal with the internal pseudo-noise code. The receiver module (10) further comprises an adaptive notch filter (36) connected between the spread spectrum signal input (14) and the receiver processor (20). Preferably, the receiver module (10) further comprises power management control means for regulating the power supply to parts of the receiver module (10). A further aspect of the invention relates to a transceiver module (10) comprising a receiver module, further including transmission means (38) for generating a spread spectrum signal, the transmission means (38) using the main frequency signal generating means (30).

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# Single Chip Spread Spectrum Receiver and Transmitter for Short Messages

The present invention relates to a spread spectrum receiver/transmitter module. In a first aspect, the present invention relates to a receiver module for receiving a spread spectrum signal having a pseudo-noise code for addressing the receiver module, comprising a receiver processor connected to main frequency signal generating means and a spread spectrum signal input, the receiver processor being arranged for generating an internal pseudo-noise code and synchronising the spread spectrum signal with the internal pseudo-noise code. In a second aspect, the invention relates to a transceiver module.

Specifically, the present invention relates to applications, in which short messages are transmitted and/or received.

In present day spread spectrum transceiver systems, the synchronisation time period is a time and power consuming action. Therefore, these spread spectrum transceiver systems are inefficient and difficult to use in low power, short data message, short range systems. Examples of such systems are identification, door opening (keyless entry), home control, alarm, and car control and measurement systems. In these systems, a transmitted spread spectrum signal (such as a BPSK modulated signal) contains a relatively short message (up to several thousands of bits) in contrast to spread spectrum systems as used in wireless LAN applications, which typically transmit millions of bits per second. Although a transmitted file may contain as few as hundred bits, these wireless systems are not developed or optimised to send short messages. Furthermore, as spread spectrum systems use a relatively wide frequency band (as compared to other transmission schemes), these systems are susceptible to interference from in-band interference sources.

The present invention tries to solve these problems by providing a receiver module for receiving a spread spectrum signal having a pseudo-noise code, which provides enough reliability and interference resistance for receiving short messages.

The present invention provides a receiver module according to the preamble of claim 1, as defined above, in which the receiver module comprises an adaptive notch filter connected between the spread spectrum signal input and the receiver processor. One or more of the characteristics of the notch filter (center frequency, bandwidth, and suppression factor) may be adapted. By adapting the notch filter to detected in-band

interference, the in-band interference may be suppressed to a large extent, ensuring proper and reliable data reception, even in presence of strong in-band interference.

The main frequency signal generating means may comprise one of alternative embodiments, e.g. a resonance circuit, free running or using a crystal or the resonance circuit may comprise a phase locked loop circuit. Each of these embodiments have their own characteristics with respect to stability, accuracy and cost, enabling a trade off between stability and accuracy of the resonance circuit and the cost of the circuit.

Preferably, receiver module is arranged to interface with further processing means for controlling parameters of the receiver module and for data processing. The control of parameters may comprise initialisation of the receiver module, setting adjustable parameters of the receiver module components. The data processing may comprise checks of cyclic redundancy codes (CRC) in the received message, data buffering, and/or stuffing. The further processing means may be external to the receiver module, or the additional functionality may be implemented by the receiver processor.

In a further embodiment, the receiver module further comprises power management control means for regulating the power supply to parts of the receiver module. By supplying power to, e.g., the RF components only during initialisation and actual reception of data, the power consumption of the receiver module may be reduced.

A spread spectrum receiver system needs to remain synchronised during the complete length of the message transmission. Due to limited frequency accuracy of pseudo-noise code clocks used in low cost equipment (at both the receiver and transmitter side), the received and internally generated receiver pseudo-noise code will show an increasing time difference during a message when the clock is not compensated continuously.

Therefore, in a further embodiment, the receiver processor is further arranged for synchronising the spread spectrum signal with the internal pseudo-noise code by means of a synchronisation machine, the synchronisation machine being arranged for determining a frequency difference between the received spread spectrum signal and the internally generated pseudo-noise code, and adjusting the main frequency signal generating means accordingly.

The initial synchronisation provided by the synchronisation machine is sufficiently accurate such that the maximum code mismatch at the end of the message

is small enough to ensure sufficient quality of data reception. Furthermore, a code-tracking loop as present in known spread spectrum systems can be omitted, allowing a less costly system.

A second aspect of the present invention relates to a transceiver module comprising a receiver module according to the present invention. Preferably the transceiver module further comprises transmission means for generating a spread spectrum signal, the transmission means using the main frequency signal generating means.

Preferably, all elements of the receiver module or transceiver module according to the present invention are integrated on a single chip, e.g. by using CMOS techniques. E.g., *for the 868 MHz licence free frequency band, it is possible to include the RF components of the modules in CMOS technique*, together with the data processing and interface components. CMOS technique allows an easy manufacturing of the integrated chips at very low cost per item.

The present invention will now be described in further detail by means of an exemplary embodiment of the transceiver module according to the present invention, with reference to the accompanying drawing.

Fig. 1 shows a block diagram of a transceiver module according to the present invention;

Fig. 2 shows a flow diagram for the state machine associated with the transceiver according to the present invention.

Fig. 1 shows a block diagram of a transceiver module 10 according to an embodiment of the present invention. The transceiver module 10 is preferably a single integrated chip, e.g. in CMOS technique, comprising an RF section 11, a digital processing section 12 and a control section 13. By adding a limited number of peripherals to the single chip transceiver module 10, a complete direct sequence spread spectrum transceiver is formed, e.g. for use in the 868 MHz license free frequency band. In one embodiment, the peripherals comprise an antenna 14, a crystal 15, a data interface coupling 16 and a micro controller 17.

The RF section 11 comprises a main clock 30 for generating a frequency signal, e.g. in the 868.3 MHz license free frequency range. The main clock 30 may be driven by a phase locked loop 31, using an external crystal 15. As alternatives, a resonance

circuit using a crystal or a free running resonance circuit may be used to generate the frequency signal.

Furthermore, the RF section 11 comprises a transmission mixer 32 and a receiver mixer 35, both connected to the main clock 30. The transmission mixer 32 receives a transmission signal from the transmitter 38 for delivering a spread spectrum output signal to the antenna 14 via the output amplifier 33. The transmitter 38 is arranged to generate a direct sequence spread spectrum signal using a pseudo-noise code associated with the transceiver module 10, using known techniques (e.g. Binary Phase Shift Keying, BPSK).

The RF section 11 further comprises an input amplifier 34 connected to the antenna 14, preferably a Low Noise Amplifier (LNA), for amplifying the received antenna signal. The input signal is mixed by the input mixer 35 to an intermediate frequency (IF) signal. The output signal of the input mixer 35 is fed to an Automatic Gain Control (AGC) 36 after which the IF signal is fed to a band limiting filter 37.

The digital processing section 12 comprises an analog-digital-converter 21, which converts the IF signal from the band limiting filter 37 into a digital signal, which is fed to a digital signal processor 20. The digital signal processor 20 implements a controllable digital notch filter. One or more parameters of the notch filter may be controlled, primarily the center frequency, but also the bandwidth of the notch filter. Of course, the controllable notch filter may be implemented separately from the digital signal processor 20, e.g. between the analog-digital converter 21 and the digital signal processor 20. The digital signal processor 20 is further arranged to analyse the received signal, and to control the controllable notch filter. Furthermore, the digital signal processor 20 is arranged to extract the spread spectrum signal having the pseudo-noise code associated with the transceiver module 10.

The digital processing section 12 further comprises a receiver data interface 22 connected to the digital signal processor 20 and a transmission data interface 23, connected to the transmitter 38. Both the receiver data interface 22 and the transmitter data interface 23 are connected to a serial communication interface 24, which interfaces with the data interface coupling 16 (e.g. a 9-pin D-type connector).

The control section 13 comprises a parallel interface 43 for interfacing with the external micro controller 17. The parallel interface 43 is connected to a main controller 40. The main controller 40 is connected to a timer 41 and a power management

controller 42. The power management controller 42 controls the power supply to the components of the three sections 11, 12, and 13 on the transceiver module 10. For reasons of clarity, the various control signal paths and power supply paths are not indicated in the block diagram of the figure.

The main controller 40 comprises a number of registers, allowing full control of the various subsystems on the transceiver module 10. This allows a very wide range of possible applications, enabling trade-offs between power consumption, acquisition time, performance and frequency range. The registers may be controlled using the external micro controller 17 via the parallel interface 43, e.g. an 8-bits parallel I/O bus with multiplexed data and address.

The RF frequency signal (Local Oscillator frequency) is controlled by the main controller 40, such that the correct frequency is chosen for either reception or transmission of a spread spectrum signal, as these will differ slightly.

The digital signal processor 20 implements the receiver functionality of the transceiver module 10. The external micro controller 17 or the internal timer 41 trigger a digital state machine, which may be implemented in a distributed manner in the control section 13 (power management controller 42 and main controller 40) and the digital signal processor 20. The flow diagram of the steps implemented by the state machine is shown in Fig. 2. In block 50, the receiver state machine awaits the trigger to start the reception cycle. When a trigger is received (e.g. once every 250 msec) the power management controller 42 turns on the RF parts of the transceiver, i.e. the local oscillator (main clock 30), the input amplifier 34, mixer 35, AGC 36 and analog-digital converter 21 (block 51). In decision block 52, the state machine checks whether the AGC 36 has settled in a steady state. As an alternative, the state machine waits for a predetermined time period after starting the AGC 36.

Subsequently, in block 53, the state machine allows the digital signal processor 20 to grab a number of samples as output by the analog-digital converter 21, and performs a discrete Fourier Transform on the samples in order to determine the strongest interference source. During the signal processing by the digital signal processor 20, the state machine turns off the RF components, i.e. the input amplifier 34, mixer 35, AGC 36 and analog-digital converter 21.

After determining the characteristics of the strongest interference source, the digital signal processor 20 sets the parameters of the controllable notch filter. Of course, when

no interference signal is detected, the notch filter may be controlled such that it passes all of the IF signal. Subsequently, the RF components (the input amplifier 34, mixer 35, AGC 36 and analog-digital converter 21) are turned on again, and the digital signal processor 20 acquires a new set of samples of the input signal, in which the notch filter has filtered the interfering signal this time. In the next step, the RF components are switched off again, and the digital signal processor 20 performs a two dimensional search on the acquired samples, in order to find the pseudo-noise code and the frequency of the signal to be received. The two-dimensional search algorithm is explained in further detail below.

In decision block 54, it is checked whether a signal has been detected. If no signal has been detected, the receiver is automatically turned off in block 55. After that, the state machine returns to block 50 to wait for the next trigger.

If a signal has been detected in block 54, the flow diagram continues with block 56, in which the internal frequency and code position are set to the found values by the digital signal processor 20. The RF components 34, 35, 36, 21 are turned on again and the receiver waits for the end of the preamble.

In decision block 57, the digital signal processor 20 checks whether the detected signal energy level drops below a certain threshold value. If this condition is true, the receiver is turned off in block 58, and the state machine returns to block 50 to await the next trigger.

If the signal energy level does not drop below the threshold the flow diagram continues in block 59, in which the RF components 34, 35, 36, 21 stay on. This block 59 is repeated until in decision block 60 the end of a message has been detected.

By using the state machine to control the power management controller 42 to only supply power to the RF components (the input amplifier 34, mixer 35, AGC 36 and analog-digital converter 21) when they are actually needed to operate, a substantial savings in power consumption of the receiver or transceiver module 10 can be achieved.

It will be clear that the receiver state machine can also be implemented in other receiver or transceiver modules, with comparable results in power consumption savings.

In the following, the two-dimensional search algorithm or pseudo-noise code synchronisation algorithm will be discussed. Preferably, this synchronisation algorithm

is implemented by the digital signal processor 20. At start up, a pseudo noise code position is selected, and the maximum found energy value is set to a threshold value. Subsequently, the pseudo-noise code position is incremented, and the sample set acquired in block 53 is multiplied by this pseudo-noise code and the expected IF frequency (I and Q). The expected IF frequency is the middle of the frequency range where the IF frequency of the incoming signal is to be expected. This results in a new complex set of samples, from which the highest frequency component can only be the highest frequency offset that is allowed. (If the synchronisation algorithm is looking at the right code position). Therefore a down sample operation is now performed on this sample set and subsequently a complex DFT is performed on this complex down-sampled sample set. The maximum energy that is detected by this DFT is stored, in combination with the related frequency and code position, and compared to the currently found maximum energy value. If this value is exceeded it is assumed that a valid signal has been detected. The same sequence is repeated for every code position. The algorithm steps back to the multiply by pseudo-noise code phase, or it goes on with the next step when all positions have been covered. After all code positions have been investigated, it is known whether or not a signal has been detected.

In a further embodiment of the present invention, the search algorithm is implemented by a synchronisation machine to provide an initial synchronisation which is sufficiently accurate to provide a code mismatch at the end of a received message which is small enough to ensure sufficient quality of data reception. This is achieved by determining the frequency difference between the internally generated pseudo-noise code and the pseudo-noise code in the received spread spectrum signal and subsequently adjusting the clock frequency of the main clock 30, e.g. by using a digital-to-analog converter.

In a further embodiment, further data processing functions, such as checks on cyclic redundancy codes (CRC), data framing/de-framing, data buffering and stuffing are implemented in the receiver data interface 22. Also, the transmitter data interface 23 may be arranged to perform associated functions. As a result, the data interfaces 22, 23 are completely autonomous for the generation of data packets and are able to determine the begin or end of messages, insert or check the CRC, add (meaningless) stuffing bytes or removing these.

In a preferred embodiment, the transceiver module 10 is controlled by the internal clock 41, allowing the transceiver 10 to be turned on or off on command of this internal timer. During a non-active stage of the transceiver duty cycle, all hardware except for the interface hardware (receiver data interface 22, transmitter data interface 23 and communication interface 24) can be turned off, resulting in a lower poser consumption. Preferably, the transceiver 10 operates at a low clock frequency, derived from the external crystal 15.

In table I, a number of characterising specifications and parameters are given, representing an actual working prototype. In the 868 MHz licence free frequency band, only a limited bandwidth of e.g. 600 kHz is available. In direct sequence spread spectrum techniques, the values mentioned in Table I for data rate, chip rate and code length may be realised. Of course, these are only examples, and trade-offs may be made between power consumption, acquisitions time, performance and frequency accuracy.

By using the controllable notch filter in the digital signal processor 20, a continuous wave interference (CWI) suppression of up to 20 dBI has been demonstrated. This allows for a reliable data reception even when strong in-band interference is present. The notch filter, preferably, has a 10 kHz bandwidth when used in a system with a RF signal bandwidth of 600 kHz.

The current consumption with a supply voltage between 2.7 and 3.3 V is very low, and amounts to only 11 mA during transmission, and 16 mA during the acquisition phase of the receiver part. When taking into account that the RF section 11 is shut down during further processing of the received signal in the digital processing section 12 during the main part of a 250 msec duty cycle (acquisition phase takes only 12 msec), the current consumption for receiving is only 1 mA. The 250 msec duty cycle in the embodiment using the parameters shown in the table (868.3 MHz, 10 kHz data rate) suffices for mission critical applications.

Preferably, all components of the transceiver module 10 (the RF section 11, digital signal processing section 12 and control section 13) are integrated on a single chip. This may, e.g. be achieved using CMOS techniques. As a result, the transceiver module 10 may be manufactured in large quantities and for low cost.

The invention has been described with reference to an embodiment of the transceiver module 10. However, it will be clear that the above will also apply to a

receiver module 10, in which the components relating to transmission of a spread spectrum signal are omitted.

The receiver/transceiver module 10 according to the present invention can be used in a large number of applications. In all applications low data rates and the acquisition method result in a small one chip, low cost solution and low power consumption.

The receiver or transceiver module 10 is primarily designed for data communication at licence free frequency bands between 860 and 920 MHz. Each of these bands have their own specifications for the use of spread spectrum concerning radio frequency bandwidth and transmitted power. Apart from regulations this depends on the application. The integrated chip itself transmits only 1 – 10 mW, but with an external amplifier (PA) this can be increased. An additional external low noise (LNA) amplifier can also improve the receiver sensitivity. In the 865 MHz frequency band, the maximum transmitted power is 500 mW and the RF bandwidth is 1 MHz, For the 868-870 MHz frequency band, the maximum transmitted power is 5, 25 or 500 mW and the RF bandwidth may be 500 or 600 MHz. In the 902-917 MHz band, the maximum transmitted power is 1W. In the near future a 6 MHz wide frequency band around 900 MHz will become available in Europe. The very same chip implementation according to the present invention can be used there. Additional frequency hopping or interference avoidance mechanisms could be implemented.

One of the application areas concerns social alarms for medical, judicial, geriatric and penal applications. The social alarms are especially designed for monitoring patients, elderly people and people under police surveillance. The problem with existing devices at 433 MHz is that these are too susceptible to interference to guarantee the required reliability. The monitoring device will consist of either a transmitter or a transceiver using a receiver or transceiver module 10 according to the present invention. The base station will consist of a receiver or transceiver, which may also use the receiver or transceiver module 10 according to the present invention. Safety and monitoring protocols usually differ in information push or pull, meaning that either the transmitter sends a regularly signal which is being monitored, or the base station transmits an information request, which is being answered. The receiver/ transceiver module 10 according to the present invention will serve both main applications.

Another field of applications is in the automotive area. In the automotive industry there are five principal applications that are typical for the 868 MHz (or future different frequencies) spread spectrum one chip solution according to the present invention. Especially for applications that are mission critical and in circumstances with a lot of interference, the present invention can be used advantageously. Applications involve systems for the transfer of data from vehicles, information from the car management system to for instance lease company or gas station (e.g., mileage, driver behaviour, energy consumption, tracking & tracing). A second mission critical application is a car data network, e.g. involving a tire pressure management system. In case the tire pressure is under a minimum level, the tire alarms the car management system for present danger. The receiver in combination with a transmitter enables to identify the tire in need of pressure. A third application is road pricing (toll) applications. The transceiver is able to transfer information from the car to a toll station. A fourth application is a wireless door opening system (RKE or Remote Keyless Entry) for doors (also applicable to fields other than automotive). The small spread spectrum device gives a reliable and secure data link with transmitter and receiver and lasts for a long time on a single battery because of the short transmit time. Since the receiver uses less than 2 mA average current and has a less than 200 ms response time it is ideal for RKE applications. The fact that longer messages are possible, makes the device suitable for additional automotive remote control applications as window, car audio or any other kind. Disabling the engine when the chip is not detected is an other application. This results in automatic protection of the car when the driver is not present. Of course this application can be used at scooters or motors as well. (A later described application will be the protection of notebooks).

A further field of applications is the field of RF identification tags. Two applications should be distinguished: "tracking and tracing" and "information and control". The tracking and tracing system would typically exist of one transceiver or transmitter to be traced by a network (multipoint to point), whereas the information and control system would exist of a base station (one or more transceivers) and several end points (point to multipoint). The low cost/low power chip solution according to the present invention enables transmitters that can be attached to shopping trolleys or shopping baskets. Thus tracking and tracing and monitoring individual customers and shopping goods in a low data rate network. A perfect application for a client

information system or protection against shoplifters. The device will typically contain a small battery (active RF tag). The difference with passive RF tags is the long range ability of this active spread spectrum tag (10 – 100 m in stead of 1,2 m). In combination with a scanner these items can be returned to the rightful owner and within the range of the network the thief can be traced. The information system can download information to displays in the shops. This could even become depending on the person who is carrying the RF tag. An even further field of applications concerns the personal field. An ID tag in combination with a scanner (two transceivers) gives the opportunity to scan the environment to search for the lost item. The ID tag is constructed that it can be attached to keys, agenda, wallet, notebook, papers of value, any kind of item that is due to frequent use moving around. By using the scanner (kind of torch) these items can easily be retrieved. By attaching a biomedical sensor, the scanner (Personal torch) can be protected for unauthorised use. The unique personal identification by the biomedical sensor attached to the transceiver allows for easy access of the personalisation code. A standard keyboard with pin code would do as well.

In cases where range and long lifetime is important, an active tag is required with zero power consumption when not needed. This problem is solved with the described transceiver 10 (which may be battery operated with power down and switch off capabilities) in combination with a passive, non spread spectrum, receiver. When the device is to be switched on, an energy burst is being transmitted to the receiver, which detects it and uses the energy to switch the transmitter on. The external signal to switch on the passive receiver/active transmitter is either close by (<50 cm) or uses high power. The frequency can differ from the 900 MHz range. The device would be used for tracking and tracing and data storage applications.

Building a low power network with the spread spectrum transceiver is an evident application. This allows for a secure and reliable building control and monitor system. The combination of the transceiver module 10 with sensors for alarm, humidity, smoke, temperature and infrared sensors allows for an intelligent building or home control system. Applications are tracking and tracing of people in a building, climate control, safety and health control. More aimed at home control would be to control the refrigerator and/or gas meter etc. In comparison with other systems in this field, the receiver/transceiver module 10 according to the present invention offers a solution that is less complex, cheaper and easier to manufacture.

The module 10 can be used to track people who are released from custody and need to be monitored during a certain period in their social environment. Difference with home based systems is that tracking and tracing can be performed outside the house independent of any other communication system (like GSM, GPS or other Satellite). Again low data rates and low power consumption are the winning factors for this system.

Another major field of applications is telemetry. The low cost one chip spread spectrum transceiver 10 has the capability for remote meter reading. Due to privacy and accuracy, meter-reading applications are not viable without spread spectrum or in a band with much interference (433 MHz). For instance, energy providers need to have information about energy consumption in order to be competitive in the market. The information of energy consumption can with this device be retrieved without the actual presence of the owner. Meter reading efficiency and accuracy will increase exponentially by building a real-time energy-monitoring network. The meter system can either contain a transmitter or a transceiver. A data collection point will contain a transceiver. Typically higher output power (100 – 500 mW) and data rates (10 or 20 kbps) will be used. A 10 year lasting battery (C- or D-type cell) will typically be used. The duty cycle can be adjustable and will typically be from 5 minutes to 24 hours.

The remote steering of bridges and cranes are mission critical applications. By connecting bridges in a low power network and a control station, the bridges can be controlled remote and 'green routes' can be implemented in waterways thus saving the environment and enhancing services for commercial and private boating. The reliability of remote control systems of cranes is deteriorating due to interference and thus giving rise to hazardous working conditions. This problem of interference of this mission critical application can be minimised by using the spread spectrum solution according to the present invention.

By using the transceiver or receiver 10 in combination with transmitters and connected sensors, it is possible to have for instance a wireless water quality management system or environmental inspection mechanism. One possible implementation is that at a critical level the sensor activates the transmitter 10, which in turn activates the transceiver 10. Thus allowing the transfer of critical data in case of leakage, pollution, or other dangers. It constructs an early warning system and enhances and improves the work conditions of employees under extreme hazardous conditions.

The other possibility would be to monitor the system with regularly and pre defined intervals (e.g. 5 minutes) and have all the data stored in a data collection system (operating as a virtual sensor). The selection of data can be performed at the data collector and only the important data will be transferred to the control system (which also could be all data). Cost becomes a critical issue, when many sensors need to be installed. Power consumption becomes a critical factor when, due to remote installation or hazardous applications like gas metering systems, battery powered systems are necessary. Size becomes a critical factor when many systems need to be low cost and easy to install and maintain.

In the process industry different phases in the production process are monitored. The one chip spread spectrum solution provides a wireless connection to the central control unit. Being a transceiver it can serve as an early warning system or as a control unit of the remote servicing of machines and appliances.

The data rate of the transceiver 10, or transmitter and receiver pair (maximum 10 or 20 kbps) allows for the transfer of compressed digital voice. Thus the use of Spread Spectrum chip can be used for the make of low cost short range communication devices like baby phones, intercoms, walkie talkies, telephones (combined with a data modem) with a secure, reliable low cost connectivity.

The one chip data communication system using the transceiver module 10 can be used in a display and data collection device (watch type of wearable device), which functions as a device for receiving and storing data of odometer signals (speed, distance etc), heartbeat and GPS-signals and other sensors related to the body functioning. The transceiver 10 has a low data rate connectivity with these various sensors and should be optimised for power and size. The same one chip transceiver 10 allows for communication from the display device (watch) to a PC.

Heart sensors, and sensors for DNA recognition, fingerprint recognition, Iris recognition, blood vessel movement, human energy etc. in combination with the transmitter, receiver or transceiver 10 can be used. The one chip device can be used as a wireless means of personal identification system in a control and monitoring system. E.g., this allows wireless connection in hospitals of heartbeat monitoring of patients possible.

Another application relates to security of payment systems (Electronic Point-Of-Sale) where a user carries a device, which has a wireless connection by means of the

one chip transmitter and receiver or transceiver device 10, with the payment card (credit or debit card). The card stops operating when the devices can not make a connection anymore. Again the active tag allows for a long range (10m) and requires a battery or an other type of energy providing device.

Table I

| **Parameter** | **Value** |
|---|---|
| RF center frequency | 868.3 MHz |
| Modulation technique | Direct Sequence Spread Spectrum |
| Data Rate | 10 kbit/s |
| Spreading Factor | 31 |
| Processing Gain | 15 dB |
| Chip rate | 310 kchips/s |
| Required Crystal Accuracy | 35 ppm overall |
| Synchronization time | <12 ms |
| Notch filter bandwidth | 10 kHz |
| In band CWI suppression | Up to 20 dBI |
| RF Bandwidth | 600 kHz |
| Out of band spurious | Complying to ETS300-220 |
| Output Power | 0 dBm |
| RX sensitivity | -105 dBm |
| Range (line of sight) | >100 m |
| Data integrity | 8 bits CRC |
| Parallel Interface | 8 bits multiplexed data/address |
| Serial Interface | Asynchronous RS232 at programmable rates |
| Current Consumption | |
| • I_TX | 11 mA |
| • I_RX during acquisition | 16 mA |
| • I_RX (duty cycle, Reaction time <250 ms) | 1mA |
| Supply voltage | 2.7 … 3.3 V |
| Temperature Range | -20°C … +60°C |

CLAIMS

1. Receiver module (10) for receiving a spread spectrum signal having a pseudo-noise code for addressing the receiver module (10), comprising a receiver processor (20) connected to main frequency signal generating means (30, 31, 15) and a spread spectrum signal input (14), the receiver processor (20) being arranged for generating an internal pseudo-noise code and synchronising the spread spectrum signal with the internal pseudo-noise code, **characterised in that** the receiver module (10) further comprises an adaptive notch filter connected between the spread spectrum signal input (14) and the receiver processor (20) for filtering the spread spectrum signal.

2. Receiver module according to claim 1, in which the receiver module (10) further comprises power management control means for regulating the power supply to parts of the receiver module (10).

3. Receiver module according to claim 1 or 2, in which the main frequency signal generating means (30) comprise a resonance circuit.

4. Receiver module according to claim 3, in which the resonance circuit comprises a crystal (15)

5. Receiver module according to claim 3 or 4, in which the resonance circuit comprises a phase locked loop circuit (31).

6. Receiver module according to one of the claims 1 to 5, in which the receiver module (10) is arranged to interface with further processing means (17; 22, 24) for controlling parameters of the receiver module (10) and for data processing.

7. Receiver module according to one of the claims 1 to 6, in which

the receiver processor (20) is further arranged for synchronising the spread spectrum signal with the internal pseudo-noise code by means of a synchronisation machine, the synchronisation machine being arranged for determining a frequency

difference between the received spread spectrum signal and the internally generated pseudo-noise code, and adjusting the main frequency signal generating means (30) accordingly.

8. Receiver module according to one of the claims 1 to 7, in which all elements of the receiver module (10) are integrated on a single chip.

9. Transceiver module (10) comprising a receiver module (10) according to one of the claims 1 to 7, further including transmission means (38) for generating a spread spectrum signal, the transmission means (38) using the main frequency signal generating means (30).

10. Transceiver module according to claim 9, in which all elements of the transceiver module (10) are integrated on a single chip.

fig-1

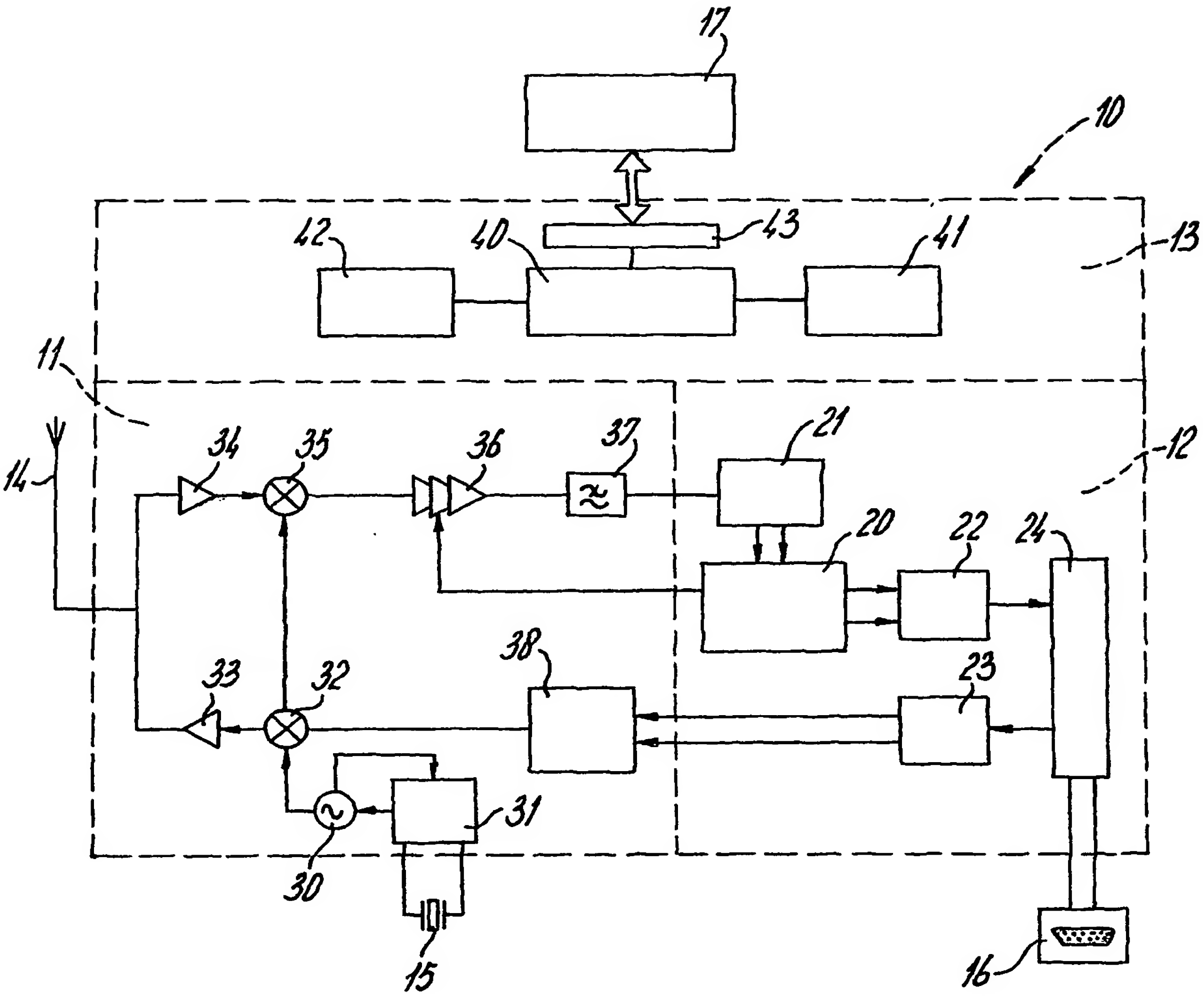
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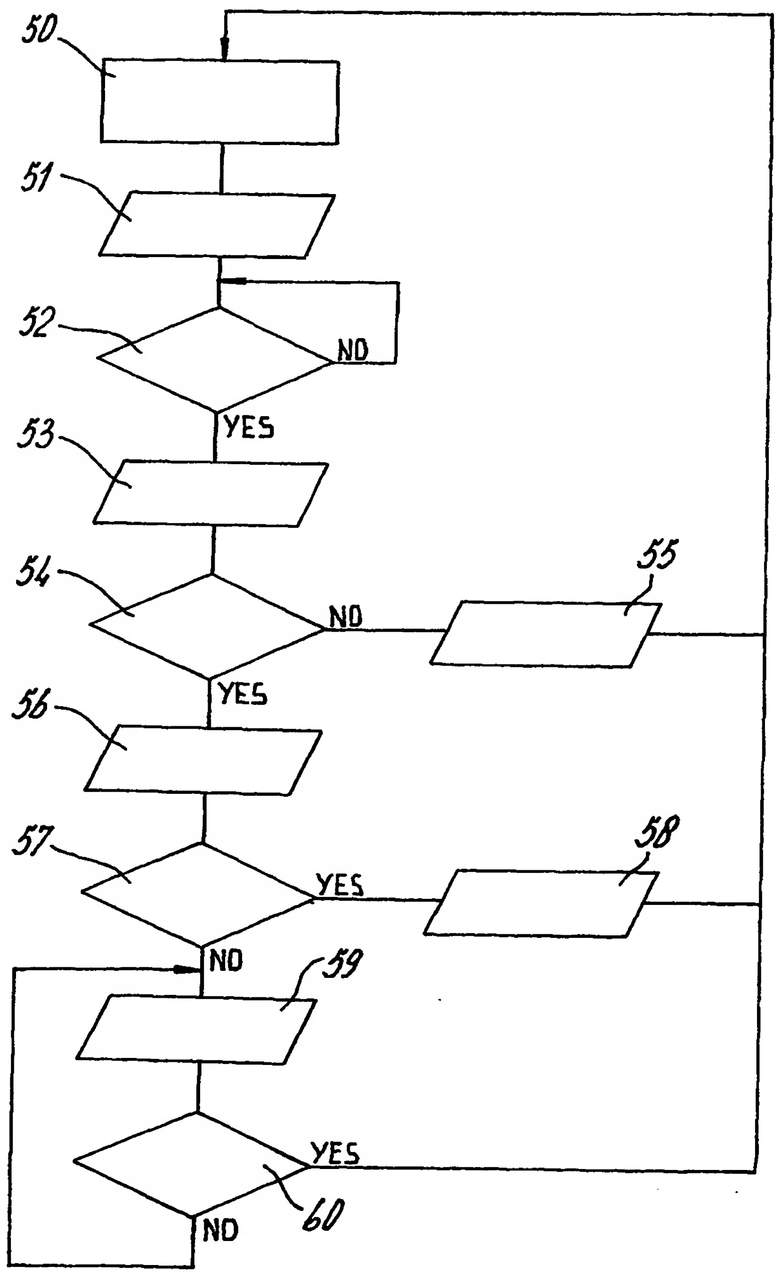
fig-2



# INTERNATIONAL SEARCH REPORT

Inte  ional Application No
PCT/NL 00/00170

**A. CLASSIFICATION OF SUBJECT MATTER**
IPC 7 H04B1/16 H04B1/707 H04B1/10

According to International Patent Classification (IPC) or to both national classification and IPC

**B. FIELDS SEARCHED**

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 H04B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal, WPI Data, PAJ

**C. DOCUMENTS CONSIDERED TO BE RELEVANT**

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| Y | abstract; figures 8,12 | 2-10 |
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| A | column 1, line 33 -column 3, line 55; figures 1,2,5-7 | 1,7-10 |
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[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

° Special categories of cited documents :

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"&" document member of the same patent family

| Date of the actual completion of the international search | Date of mailing of the international search report |
|---|---|
| 8 November 2000 | 16/11/2000 |
| Name and mailing address of the ISA<br>European Patent Office, P.B. 5818 Patentlaan 2<br>NL – 2280 HV Rijswijk<br>Tel. (+31-70) 340-2040, Tx. 31 651 epo nl,<br>Fax: (+31-70) 340-3016 | Authorized officer<br>Andersen, J.G. |

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C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

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